



Technical Support Document: Toxicology Clandestine Drug Labs: Methamphetamine

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AMMONIA

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Introduction

The clandestine synthesis of methamphetamine (meth) and other illegal drugs is a growing public health and environmental concern. For every pound of meth synthesized there are six or more pounds of hazardous materials or chemicals produced. These are often left on the premises, dumped down local septic systems, or illegally dumped in backyards, open spaces, in ditches along roadways or down municipal sewer systems. In addition to concerns for peace officer safety and health, there is increasing concern about potential health impacts on the public and on unknowing inhabitants, including children and the elderly, who subsequently occupy dwellings where illegal drug labs have been located.

The Office of Environmental Health Hazard Assessment (OEHHA), in cooperation with the Department of Toxic Substances Control (DTSC), has been charged with assisting in identifying and characterizing chemicals used or produced in the illegal manufacturing of methamphetamine, which pose the greatest potential human health concerns. To address in part this growing environmental problem and the need for public health and safety professionals to make appropriate risk management decisions for the remediation of former methamphetamine laboratory sites, OEHHA has developed two types of chemical-specific information documents.

The first set, technical support documents (TSDs), are referenced, multi-page publications, which contain important health and safety data, exposure limits, and key information for recognizing chemicals used or produced during the manufacturing of methamphetamine. These documents will likely be most helpful to health and safety officers, industrial hygienists, or others interested in more detailed toxicological information. The second set, two-page fact sheets, contain much of the same information as the corresponding TSDs; however, the details are presented in a more succinct, graphical format. The fact sheets will be helpful to individuals, including the public, who want to be able to quickly recognize potential chemicals of concern found in illegal methamphetamine labs in order to avoid inadvertent exposures and resulting health impacts.

For more information or to obtain copies of these and other documents, contact:

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I. Chemical Name

A. AMMONIA (NH₃)

B. Synonyms

Ammonia gas, liquefied anhydrous ammonia (HSDB, 2001).

NOTE: Anhydrous ammonia is a gas at room temperature, and becomes a liquid when compressed. If not stored in pressurized tanks, it quickly evaporates. Anhydrous ammonia produces low temperatures by its own evaporation; therefore, a major use is in refrigeration (ARB, 1997). In contrast, aqueous ammonia for household cleaning (for example, "Parson's Ammonia") contains 5-10% ammonia in water (HSDB, 2001). Household ammonia is not used for clandestine synthesis of methamphetamine.

II. Role in Clandestine Drug Synthesis: Methamphetamine

Anhydrous ammonia is used with an alkali metal (typically lithium or sodium) in the "Nazi Method" to convert ephedrine to methamphetamine.

III. Chemical Description

A. Appearance

Ammonia is a colorless gas at room temperature and easily dissolves in water (ATSDR, 2000). In clandestine methamphetamine labs, anhydrous ammonia is often stored in insulated coolers, small propane fuel cylinders, and five-gallon propane tanks. Blue or green corrosion on valves and fittings is a good indicator that the cylinders contain ammonia (Turkington, 2000).

B. Taste

Not applicable. Anhydrous ammonia is a gas at room temperature.

C. Odor

Pungent, suffocating odor (HSDB, 2001).

D. Odor Threshold

5 ppm (ATSDR, 2000; Amoore & Hautala, 1983).

E. Irritancy Threshold

Twenty ppm is reported to cause discomfort and complaints in workers who are unaccustomed to ammonia vapor (HSDB, 2001). Airborne concentrations of 50-100 ppm will cause irritation of the eyes, nose, and throat (ATSDR, 2000).

F. Odor Safety Class

C (Amoore & Hautala, 1983); less than 50% of distracted individuals perceive warning of the threshold limit value (TLV) concentration of 25 ppm (Amoore & Hautala, 1983). *Therefore, odor is not an adequate indicator of the presence of ammonia vapor and does not provide reliable warning of hazardous concentrations.*

G. Vapor Density

The vapor density of ammonia is 0.59 (air = 1); therefore, it is lighter than air (ATSDR, 2000; ARB, 1997). However, since vapors from liquefied ammonia are initially colder than air, they may concentrate near the ground and in low-lying areas until they warm to room temperature.

H. Vapor Pressure

7,520 mmHg at 25° C (HSDB, 2001).

IV. Containers and Packaging

A. Commercial Products

Anhydrous ammonia is typically found in tanks as pressurized, liquid ammonia and can be obtained from farms that use it for fertilizer or from blueprint machines (Turkington, 2000).

B. Pharmaceutical Use

No pharmaceutical uses for anhydrous ammonia were identified. Aromatic ammonia spirit, containing 15% ammonia and 35% alcohol, is used as a respiratory stimulant (USP, 1998).

V. Chemical Hazards

A. Reactivity

Ammonia reacts with strong oxidizers, acids, halogens, bleach, salts of silver, zinc, copper, and other heavy metals. It is corrosive to copper and galvanized surfaces (ATSDR, 2000). Reaction with halogens, oxidizers, and oxidizing gases (chlorine, bromine, and iodine) may be violent and/or may form explosive products (HSDB, 2001).

B. Flammability

Ammonia is considered nonflammable; however, it will explode if ignited. Explosive concentrations are in the range of 15 to 28% (HSDB, 2001; ATSDR, 2000). Therefore, even though anhydrous ammonia does not meet the U.S. Department of Transportation definition of a flammable gas, it should be treated as one (NIOSH, 1997).

C. Chemical Incompatibilities

Ammonia is incompatible with acids, aldehydes, amides, halogens, heavy metals, oxidizers, plastics, and sulfur (Meditext, 2003).

VI. Health Hazards

A. General

Ammonia is irritating to the upper respiratory tract, skin, and eyes. Exposure to ammonia vapor can cause tearing of the eyes and irritation of the nose and throat. Direct contact can cause severe burns, especially to the eyes, which may lead to blindness. Burns of the skin will feel soapy and may appear gray-yellow to black in color. Ingestion will produce burns to the lips, mouth, and esophagus.

B. Acute Effects

Liquefied anhydrous ammonia is hazardous by all routes of exposure (inhalation, skin contact, and ingestion). The liquid is capable of burning the skin, causing permanent eye damage, and corroding the digestive tract upon contact. The gas is capable of causing severe eye damage, pulmonary edema, inflammation and edema of the larynx, and death from spasm (HSDB, 2001). Effects on the respiratory tract include inflammation, which can lead to wheezing, shortness of breath, and chest pain. Inhalation of vapor from concentrated, industrial strength ammonia may cause burns to the respiratory tract. Eye exposure can cause symptoms ranging from tearing, inflammation, and irritation to temporary or permanent blindness (Meditext, 2003). A single exposure to a high concentration of ammonia gas reportedly causes residual chronic bronchitis. Chronic obstructive pulmonary disease occasionally develops as a consequence of fibrous obstruction of the small airways (HSDB, 2001). Ingestion of aqueous ammonia cleaning solutions may produce nausea, vomiting, as well as swelling of the lips, mouth, and throat. Ingestion of concentrated solutions may cause burns to the mouth and esophagus. In addition, blood pressure and pulse may increase following exposure (Meditext, 2003).

C. Chronic Effects

Repeated exposure may lead to chronic irritation of the respiratory tract (ATSDR, 2000). Cough, asthma, lung fibrosis, chronic eye and skin irritation, and breathing difficulty on exertion are symptoms of repeated exposures (HSDB, 2001; Meditext, 2003). Headache and drowsiness also have been reported (Meditext, 2003).

D. Skin Contact

A chemical burn can result from direct contact, which may feel soapy due to the action of ammonia on fat in tissue. Liquefaction necrosis (cell and tissue death) and deep penetrating burns can result. Less severe injury may be recognized by gray-yellow soft regions of skin. In more severe cases, the skin appears black and leathery (Meditext, 2003). Blistering can also occur (ARB, 1997). Anhydrous ammonia is usually stored at -28°F , and direct contact with liquefied anhydrous ammonia can cause frostbite (ATSDR, 2000; Meditext, 2003).

E. Eye Contact

Airborne concentrations of 50-100 ppm can cause eye irritation. Higher concentrations can cause severe eye injury, including burns (ATSDR, 2000; Meditext, 2003). Direct contact with aqueous ammonia solutions can cause severe and permanent eye injury including blindness. Complete damage may not be detected for up to one week after the initial injury is sustained (ATSDR, 2000). Severe exposure can damage the iris and cause cataracts. Hemorrhage, extensive loss of pigment, and severe glaucoma can result (Meditext, 2003).

F. Inhalation

Inhalation of ammonia at concentrations of 50-100 ppm and greater will cause irritation of the nose and throat (ATSDR, 2000). Because of the high water solubility of ammonia, the upper airways (nasal passages, larynx, and trachea) are more likely to become irritated than the lower airways. The severity of injury from exposure to ammonia increases with increasing concentration and duration of exposure, and ranges from mild cough to swelling of the larynx and life-threatening pulmonary edema (accumulation of fluid in the lungs). Typical symptoms include shortness of breath, difficulty breathing, laryngitis, wheezing, and bronchospasm. Cessation of breathing may occur following severe exposure (Meditext, 2003). Constriction of the upper airways has been reported to occur at concentrations of ammonia below the threshold for eye irritation (HSDB, 2001).

G. Ingestion

If an aqueous ammonia solution is ingested, nausea and vomiting frequently occur. Ingestion of concentrated solutions may produce swelling of the lips, mouth, and larynx, as well as burns of the mouth and esophagus (Meditext, 2003). Extensive systemic absorption may result in convulsions and coma (HSDB, 2001).

H. Predisposing Conditions

Persons with pre-existing asthma or other respiratory problems, including cardiopulmonary disease, are likely to be more sensitive to the adverse effects of ammonia. These individuals may experience airway constriction at relatively low concentrations (OEHHA, 1999). Persons taking high doses of aspirin, and persons receiving therapy with valproic acid (i.e., Depakote), essential amino acids, or hyperalimentation may have elevated blood ammonia levels (HSDB, 2001; OEHHA, 1999). Similarly, individuals with severe liver disease frequently have elevated levels of ammonia in their blood and cerebrospinal fluid. Theoretically, these conditions would enhance the sensitivity of these individuals to systemically absorbed ammonia. However, the toxic effects of ammonia are primarily due to its direct corrosive action, and systemic toxicity is rarely observed. Therefore, except in cases of severe exposure where systemic absorption has occurred, enhancement of the toxicity of ammonia by the conditions listed above is unlikely. Eye contact with liquid ammonia or ammonia vapor may produce more serious effects in persons with corneal disease or glaucoma (HSDB, 2001).

I. Special Concerns for Children

Children may inhale relatively larger doses of ammonia due to their greater lung surface area to body weight ratio and increased minute volumes to weight ratio. Children could also receive higher doses due to their short stature and the higher levels of ammonia vapor that may be present near the ground when a container of liquefied anhydrous ammonia is opened (ATSDR, 2000).

VII. First Aid

A. Eyes

Flush exposed eyes with water or saline solution for at least fifteen minutes. Remove contact lenses if easily removable. Seek medical help if needed.

B. Skin

Remove contaminated clothing. Flush exposed skin and hair with water for at least five minutes and thoroughly wash with soap and water when possible. Treat burns as directed by medical personnel.

C. Ingestion

Do not induce vomiting, do not administer activated charcoal, do not perform gastric lavage, and do not attempt neutralization. Conscious victims should be given 4-8 ounces of water or milk. Seek medical attention if needed.

D. Inhalation

Move to fresh air and administer oxygen if needed. If breathing difficulty occurs, get medical attention.

VIII. Standards for Inhalation Exposure

A. Occupational Exposure Limits (NIOSH, 1997; ACGIH, 1994)

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|--|----------------------------------|
| 1. Ceiling Limit (C) (not to be exceeded at any time): | Not established. |
| 2. Short-Term Exposure Limit (STEL or ST): | 35 ppm (24 mg/m ³) |
| 3. 8-Hour Time Weighted Average (TWA): | 25 ppm (17 mg/m ³) |
| 4. 10-Hour Time Weighted Average (TWA): | 25 ppm (17 mg/m ³) |
| 5. Immediately Dangerous to Life & Health (IDLH): | 300 ppm (210 mg/m ³) |

Important Definitions Follow:

Ceiling Limit (C) is a concentration that must not be exceeded during any part of the workday.

Short-Term Exposure Limit (STEL or ST) is a 15-minute time-weighted average concentration that should not be exceeded during any part of the workday.

8-Hour Time Weighted Average (8-hour TWA) concentration is an exposure standard that must not be exceeded during any 8-hour work shift of a 40-hour workweek. 8-Hour TWA exposure standards established by the Occupational Safety and Health Administration (OSHA) are called Permissible Exposure Limits (PELs). 8-Hour TWA exposure standards established by the American Conference of Governmental Industrial Hygienists (ACGIH) are called Threshold Limit Values (TLVs).

10-Hour Time Weighted Average (10-hour TWA) concentration is an exposure standard that must not be exceeded during a 10-hour workday of a 40-hour workweek. 10-Hour TWA exposure standards developed by the National Institute for Occupational Safety and Health (NIOSH) are called Recommended Exposure Limits (RELs).

Immediately Dangerous to Life & Health (IDLH) defines a concentration which poses a threat of death or immediate or delayed permanent health effects, or is likely to prevent escape from such an environment in the event of failure of respiratory protection equipment. IDLH values are developed by the National Institute for Occupational Safety and Health (NIOSH).

"Skin" notation (NIOSH): significant uptake may occur as a result of skin contact. Therefore, appropriate personal protective clothing should be worn to prevent dermal exposure.

B. Emergency Response Planning Guidelines (1 hour or less) (AIHA, 2002)

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|--|----------------------------------|
| 1. ERPG-1 (protective against mild, transient effects): | 25 ppm (27 mg/m ³) |
| 2. ERPG-2 (protective against serious adverse effects): | 150 ppm (105 mg/m ³) |
| 3. ERPG-3 (protective against life-threatening effects): | 750 ppm (525 mg/m ³) |

Emergency Response Planning Guidelines (ERPGs) are developed by the American Industrial Hygiene Association (AIHA) to assist in planning and preparation for catastrophic accidental chemical releases. ERPGs allow emergency response planners to estimate the consequences of large-scale chemical releases on human health, and evaluate the effectiveness of prevention strategies and response capabilities. ERPGs assume that the duration of exposure is one hour or less. They are not intended to be used as limits for routine operations and are not legally enforceable.

Definitions for the three ERPG levels are:

ERPG-1: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing more than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.

ERPG-2: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.

ERPG-3: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

C. Acute Reference Exposure Levels (1-hour exposure) (OEHHA, 1999)

- | | |
|---|----------------------------------|
| 1. Level protective against mild adverse effects: | 4.5 ppm (3.2 mg/m ³) |
| 2. Level protective against severe adverse effects: | 110 ppm (78 mg/m ³) |
| 3. Level protective against life-threatening effects: | 340 ppm (240 mg/m ³) |

D. Chronic Reference Exposure Level (multiple years) (OEHHA, 2002)

Level protective of adverse health effects: 0.3 ppm (0.2 mg/m³)

Reference Exposure Levels (RELs) are developed by the California EPA's Office of Environmental Health Hazard Assessment (OEHHA). A REL is a concentration at or below which no adverse health effects are anticipated, even in the most sensitive members of the general population (for example, persons with pre-existing respiratory disease). RELs incorporate uncertainty factors to account for information gaps and uncertainties in the toxicological data. Therefore, exceeding a REL does not necessarily indicate an adverse health impact will occur in an exposed population. Acute RELs are based on an assumption that the duration of exposure is one hour or less. Chronic RELs are intended to be protective for individuals exposed continuously over at least a significant fraction of a lifetime (defined as 12 years).

E. Chronic Reference Concentration (lifetime exposure) (IRIS, 1997)

Level protective against health effects:

0.14 ppm (0.1 mg/m³)

IX. Environmental Contamination Concerns

A. Surface Water

Under normal (aerobic) conditions, bacteria rapidly convert ammonia to nitrate, creating a biochemical oxygen demand (BOD) several days after the introduction of ammonia. This leads to depletion of dissolved oxygen and can result in the death of aquatic organisms. Temperature, oxygen supply, salinity, and pH of the water influence the rate of this reaction (HSDB, 2001).

B. Groundwater

If spilled onto soil, ammonia is converted by bacteria to nitrate, which is highly mobile. Groundwater contamination by nitrate is a major concern in agricultural areas where ammonia and other nitrogen-based fertilizers are heavily used.

C. Drinking Water

No information available.

Suggested No Adverse Response Level (NAS, 1980):

Not established.

Preliminary Remediation Goal for Tap Water (U.S. EPA, 2002 Region IX):

Not established.

D. Soil

Ammonia strongly adsorbs (binds) to soil and sediment particles (HSDB, 2001). In soil, plants and microorganisms rapidly take up ammonia (ATSDR, 2000). Bacteria in soil convert ammonia to nitrate, which is highly mobile in soil and a potential threat to groundwater.

Preliminary Remediation Goal for Residential Soil (U.S. EPA, 2002 Region IX): Not established.

E. Air

Gas-phase ammonia is subject to wet deposition (washout by rainfall), dry deposition, reaction with gas-phase nitric acid to produce ammonium nitrate, and reaction with aerosols to produce ammonium salts (ARB, 1997).

Preliminary Remediation Goal for Ambient Air (U.S. EPA, 2002 Region IX): 0.14 ppm (0.1 mg/m³)

F. Indoor Surface Contamination

Contamination of indoor surfaces by anhydrous ammonia is not a concern. If spilled onto a non-porous surface, liquefied anhydrous ammonia will not remain, because it is a gas at room temperature. Porous materials such as concrete and wood may absorb ammonia and delay its rate of evaporation, but eventually all of the chemical will dissipate.

X. Personal Protective Equipment

Chemical protective clothing and gloves should be composed of butyl rubber, natural rubber, neoprene, nitrile rubber, or polyvinyl chloride (not Viton). Clothing and gloves may provide little or no thermal protection; this is a concern, because anhydrous ammonia is capable of causing frostbite. Fully encapsulating, vapor protective clothing should be worn along with a positive pressure self-contained breathing apparatus (SCBA) if ammonia is spilled or leaks and there is no fire (HSDB, 2001).

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